EXERCISE APPARATUS FOR EXERCISING LOWER LIMBS

The present invention relates to an exercise apparatus for exercising lower limbs. In particular, the object of the present invention is an exercise apparatus for exercising lower limbs for practising ski touring, activity wherein the same work concurrently at different bending/extension angles performing an alternating eccentric and concentric muscular exercise.

By eccentric muscular exercise it is meant a muscular contraction performed in extension, that is, when the muscle is extended by an external strength exceeding that it develops. By concentric muscular exercise it is meant a muscular contraction with subsequent shortening of the muscle concerned. For example, in practising ski touring, at the beginning of the curve the legs are extended and feet are at the maximum distance from the pelvis. The first curve step (bending) corresponds to eccentric exercise for lower limbs until the maximum bending level is reached such that, even if standing at the minimum distance from the pelvis, the "downstream" foot is farther from the "upstream" foot and the two lower limbs are at different bending angles. The second curve step (bending), on the other hand, is characterised by a concentric exercise of both lower limbs, which begin to contract starting from different bending angles and end

the concentric contraction when the lower limbs are at the maximum extension and the foot-pelvis distances are maximum. In particular, ski touring is characterised by movements called "of counter-resistance" of both lower limbs of the human body at different bending/extension angles of the pelvis, hip, knee and ankle joints, variable during the movement.

In addition, in performing curves in ski touring, the movement of shortening/extension of the distance between food and hip occurs concurrently, but in a differentiated manner for the two lower limbs of the human body.

Machines for exercising lower limbs, in particular for performing ski touring, of the known type, which are generally provided with a complex structure, do not satisfactorily reach the exercising targets illustrated above.

The object of the present invention is to realise an exercise apparatus for exercising lower limbs, the use of which by the user should be safe, simple and comfortable.

Another object of the present invention is to realise an exercise apparatus for exercising lower limbs which should allow obtaining a specific training for an exercise wherein lower limbs work concurrently at different bending/extension angles performing an

eccentric and concentric muscular exercise in an alternating manner.

Another object of the present invention is to realise an exercise apparatus for exercising lower limbs which should be particularly simple and functional, with low cost.

These objects according to the present invention are achieved by realising an exercise apparatus for exercising lower limbs as illustrated in claim 1.

Further features are disclosed in the dependent claims.

The features and advantages of an exercise apparatus for exercising lower limbs according to the present invention will appear more clearly from the following exemplificative non-limiting description, made with reference to the attached schematic drawings, wherein:

Figure 1 shows a plan view of an exercise apparatus for exercising lower limbs object of the present invention in a central starting position;

figures 2 and 3 show plan view of the exercise apparatus of figure 1 respectively in working positions on opposed sides;

figure 4 shows a side elevation view of the exercise apparatus of figure 3;

figures 5 and 6 respectively show plan and elevation views of a second embodiment of an exercise apparatus

for exercising lower limbs according to the present invention;

figure 7 shows an enlarged detail of the apparatus of figures 5 and 6.

With reference to the figures, there is shown an exercise apparatus for training lower limbs globally indicated with reference numeral 10 and comprising a carrying structure 12 to which a seat for the user 13, a support and guide member 14 of two footboards 15, or support bases for feet, are constrained. An actuator 16, in the example shown, is connected at opposed ends to the carrying structure 12 and to the support and guide member 14 of footboards 15 respectively. The carrying structure 12, which is made of metal or of another material, and whose shape is unimportant for the objects of the invention, must only be capable of withstanding the stresses generated during the use of apparatus 10 and of providing firm anchoring to the fixed or oscillating elements that make up such apparatus, without hampering its motion.

In a first embodiment, shown in figures from 1 to 4 by way of an example, the support and guide member 14 of footboards 15 is shaped as a bar, which is constrained to the carrying structure 12 with a pin or fulcrum 17 and forms a lever arm, adapted for performing a hunting

motion around fulcrum 17 on a preferably horizontal plane.

Footboards 15 applied to bar 14 at the opposed end relative to fulcrum 17, describe a curvilinear trajectory around fulcrum 17 and exert a power, schematised in figures 2 and 3 with arrow F, directed towards the user sitting on seat 13 during the entire performance of the exercise.

The two footboards 15, one for the right foot and the other for the left foot, are turnably applied to a plate 18 by an articulated joint 19, which allows their controlled rotation around an axis. Articulated joint 19 can, moreover, impose an adjustment and a restriction to such rotation of footboards 15. The footboards are further provided with a means for adjusting the reciprocal distance 20, in approach and in removal, schematically shown in figures from 1 to 3. The distance of footboards 15, in fact, can be changed on the basis of the user's anthropometrical features to improve comfort during the exercise performance and to change the working conditions.

Moreover, footboards 15 consist of a suitable material for withstanding mechanical stresses and they can have an anti-slip coating, such as for example a rubber or abrasive material surface. Always to improve the user's safety and comfort in performing the exercise, the

footboards may be provided with foot locking members, such as for example straps or other means not shown.

The footboard support plate 18 is applied to the support and guide member 14, for example by a shaft or connecting member 23, protruding from the guide member 14, and is free to rotate around the axis of shaft 23 relative to a starting position shown in figure 1. The rotation occurs with an angular travel equal to +/- α, with α variable on the basis of the user's needs, relative to the position of figure 1, wherein plate 18 is perpendicular to the directrix, shown in figures 2 and 3 with a dash-dot line, generated between the centre of rotation of plate 18, determined by the axis of shaft 23, and the centre of rotation of seat 13 consisting of a support pin 24.

The position of shaft 23, and thereby of the footboard carrying plate 18, relative to the support and guide member 14 of footboards can be changed by an adjustment means, or slide 26 schematically shown in the figures, for example for adapting the exercise apparatus 10 to the exercise to be performed or to the user's physical structure. During the performance of the exercise for training lower limbs, the footboard carrying plate 18 arranges in angled position relative to the starting position, so as to allow a higher extension of the external leg with respect to the internal one, and

simulate the natural movement of lower limbs during ski touring.

In the embodiment shown, actuator 16, for example, is a pneumatic piston mobile in a cylinder and constrained to the support and guide member 14 of footboards 15 by a connecting element, or shaft, 21, whose position on member 14 is preferably adjustable, for example. Such adjustment, which allows changing the exercise performance speed or the exerted power, is realised by a further adjustment means, or slide, not shown, which is located on the opposite side of bar 14 relative to slide 26 for adjusting the footboard carrying plate 18. Optionally, actuator 16 can consist of an electrical motor or other equivalent means adapted for interacting with the lever arm 14 as described.

The point of application of actuator 16 to bar 14, which in the example is located in the proximity of footboards 15, could also be arranged in the proximity of fulcrum 17 or even at the opposite side relative to it.

At the opposed end, actuator 16 is turnably constrained to the support structure 12, or to another support, for example by a hinge 25. By varying the power exerted by the actuator, the strength the user must oppose during the exercise is changed, that is, a quantity which actually corresponds to the strength to which the skier's lower

limb muscles are subject during the curve. Moreover, it is possible to change the speed at which footboards 15 approach the user's body, a quantity that actually corresponds to the muscle's extension speed during the first step of performance of the curve. This is realised, for example, by changing the position of the constraint point of actuator 16 to the support and guide member 14 of footboards 15, for example by adjusting the position of connecting shaft 21 on the slide. Such change also affects the strength transmitted to the user.

Further possible adjustments consist in changing the piston stroke of actuator 16, as well as in restricting the angular travel of the lever arm 14. In fact, the lever arm 14 rotates around fulcrum 17 describing a hunting motion with angle +/- β relative to a longitudinal axis of the apparatus determined by the generatrix between fulcrum 17 and the pin of rotation of seat 24, wherein angle β varies on the basis of the user's needs. According to a first exercising method, the hunting motion is performed alternately on opposed sides relative to the apparatus' longitudinal axis. The exercise apparatus 10 can also be used for performing a hunting motion on a single side, for example for rehabilitation purposes.

The speed and the power applied by actuator 16 can, moreover, be variable in an irregular manner, through

rotation of actuator 16, to simulate as much as possible the irregularities felt on the legs during the downhill race on a ski slope.

An electronic control system of actuator 16 allows developing different powers on the basis of the eccentric and/or concentric muscular working step, moreover according to customised schedules for each user.

Moreover, according to a further embodiment of the apparatus according to the invention shown in figures 5 to 7, loading cells 33, schematically shown in figure 7, are applied to each footboard 15, which measure the load distributed at any moment by the user on each footboard. The loading cells, interfaced in a known manner with a display 34 allow the user to check and improve the ability of distributing the load on both lower limbs.

The user's seat 13, which can be adjusted so as to vary the angle between seat 27 and back 28, is connected to the carrying structure 12 by a support pin 24, which allows the rotation of seat 13 around the axis of pin 24. In a possible embodiment shown in the figures by way of an example, the support pin 24 is fastened to a plate or base 32 integral with the support structure 12.

There are also provided means for adjusting the position of seat 30, placed between pin 24 and plate 32, in particular the distance between the rotation pin 24 of seat 13 and fulcrum 17 of the support and guide member

14 of footboards 15, which must be changed on the basis of the user's anthropometric features or of the training method, as schematically shown with a dashed line in figures 1 and 2.

Seat 13 is provided with two handles 31 that allow the user to perform the exercise in a more comfortable and safe manner. Moreover the exercise apparatus 10, to ensure higher use safety, comprises a safety device, not shown, for example actuable by the user by a button located on one of the two handles 31, which controls the actuator to allow its user-controlled deactivation. The safety device can also cause the automatic deactivation of the actuator when a fixed threshold value of the exerted power is reached.

Figures 5 and 6 show a further embodiment of an exercise apparatus for exercising lower limbs 10' according to the present invention. Only additional components shall be described below compared to what described for the first embodiment of apparatus 10, to which reference shall be made for common parts.

The figures show a carrying structure 12 that can be made modular for transport reasons, comprising a safety case 32 for actuator 16, a plurality of seats 36 for a member 37 for stopping the hunting motion arranged on a curved track 38 and a strengthening member 39 on which

the support and guide member 14 of footboards 15 is pivoted.

The support and guide member 14 of footboards 15 comprises, in fact, two parallel bars, which in the example shown are connected by a vertical stiffening plate 40 pivoted to the carrying structure 12. The bars for a C-shaped structure to which the top and bottom support plates 18 of footboards 15 are constrained through the connecting shaft 23. Plates 18, integral with one another, are turnable around the vertical axis of shaft 23.

Apparatus according to claim 7, characterised in that each of said footboards (15) comprises a frame (41) connected by said articulated joint (19) to a top plate (18) and to a bottom plate (18) integral to one another, as well as a support surface (42) for the foot, hinged to said frame (41) according to a horizontal axis. Footboards 15 are connected to one another by a bar or cam 43 which, as shown in figure 5, connects the bottom portion of the two frames 41. The integral motion of footboards 15 is intended to make the apparatus use safer, that is, reduce the risk of accidents.

Moreover, in the exercise apparatus 10' of the present invention, footboards 15, or plates 18, are connectable to the carrying structure 12 by an additional bar 44, removable and with adjustable height, which arranges as

pantograph parallel to bars 14 to keep the support plates 18 of the footboards orthogonal relative to a longitudinal axis of the apparatus during the exercise, as shown in figure 5, or at a different fixed angle, which in any case remains constant during the exercise. This expedient allows quicker learning of the proper method of use of the apparatus while maintaining the function of power training unchanged, in particular when high loads are applied for training. Different methods for power training are thereby realised, by locking the support plates 18 at a fixed angle, either orthogonal or not, relative to the longitudinal axis of apparatus 10', which allows the lower limbs to exercise starting from different bending/extension degrees, as well as to control the distribution of strength on the two footboards when apparatus 10' is used without locking the support plate 18.

Alternatively to the additional bar 44 there can be provided other adjustable means for locking the support plates 18 of the footboards during the exercise at a fixed angle relative to a longitudinal axis of the apparatus. Apparatus 10' further comprises a braking device 45 for restricting the relative motion between the support and guide member 14 of footboards 15 and the support plates 18 of footboards 15 themselves. A disc 46 pressed against the top plate 18 by an adjustable stem

47 brakes by friction the rotating motion of plates 18, or of footboards 15 with a strength adjustable by the user. Means 48 for measuring the relative rotation between the support plates 18 of the footboards and the support and guide member 14 of the same, for example consisting of an encoder, are, moreover, schematically shown in figure 6.

From the measurement of the relative clockwise and counter-clockwise rotation of plates 18 relative to the support member 14 it is possible to obtain and optionally view on display 34 both the exercise performance speed and the motion control ability, intended as reduction of the oscillations of relative rotation. The exercise apparatus for exercising lower limbs 10, object of the present invention, is used by sitting on seat 13, gripping handles 31 and placing the feet on footboards 15. At this point, with a free movement of extension of lower limbs, the user moves footboards 15 for example alternately to his/her right and to his/her left, making the same perform a curvilinear trajectory with an angular travel with angle β on each side. In performing this exercise, the user will have to oppose the power exerted by actuator 16 that returns footboards 15 to the starting position.

According to a further operating method, the actuator exerts resistance also against the extension movement.

The exercise apparatus for exercising lower limbs object of the present invention, advantageously allows very accurate reproduction of the movement of lower limbs of the human body during the practise of ski touring, activity wherein the same work concurrently at different bending/extension angles performing an alternating eccentric and concentric muscular exercise.

In fact, the apparatus advantageously allows making both lower limbs of the human body work with a movement called of "counter resistance", at different and adjustable bending/extension angles of the pelvis, hip, knee and ankle joints.

Moreover, the exercise apparatus according to the present invention exhibits the advantage of exerting a direct power to the user sitting on the seat, thereby allowing the performance of an eccentric muscular workout alternating to the concentric one. Another advantage of the exercise apparatus is that of allowing the performance of a movement of shortening/extension of the distance between food and hip in a concurrent manner, so as to simulate the muscular action characterising the performance of curves in ski touring.

Moreover, advantageously, the exercise apparatus according to the present invention allows both a power training and a control exercise. The exercise

apparatus for exercising lower limbs thus conceived can be subject to several changes and variants, all falling within the scope of the invention; moreover, all details can be replaced with technically equivalent elements. In the practice, the materials used as well as sizes, can be of any type according to the technical requirements.